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(54) Optical encoder

(57) An optical motion encoder for translation of movement information into a digital output. The optical encoder includes an optical member having a parabolic reflecting surface and a planar surface with a code pattern printed thereon. The light rays received by the parabolic reflecting surface from a light source positioned on the axis of symmetry of the parabolic reflecting surface are reflected as parallel light rays through the planar surface to be modulated by the code pattern and detected by a light detector. In this way, both, the collimator and the code wheel or code strip of prior art optical encoders are represented by a single optical member.

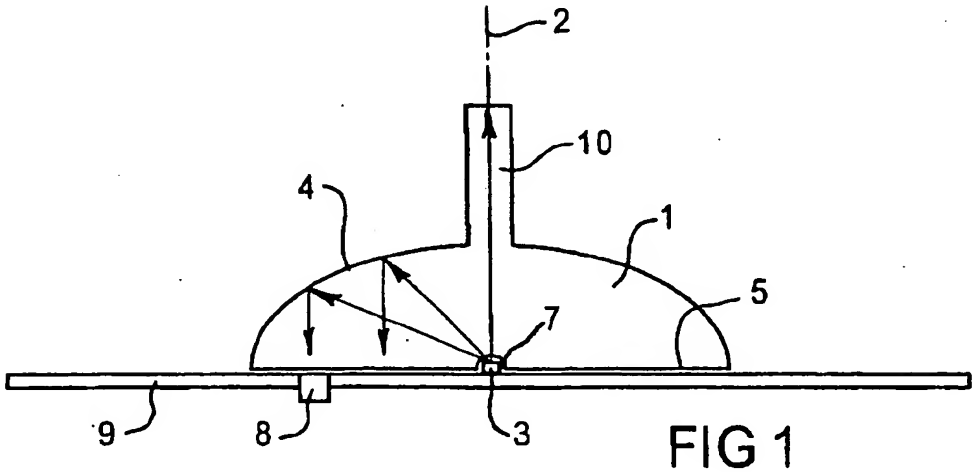

FIG 1

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erence axis. Preferably, the reflecting surface is an parabolic surface symmetrical about the reference axis.

[0015] The optical member further includes a planar surface which is perpendicular to the reference axis for receiving the parallel light rays reflected from the reflector surface and is provided with a code pattern for modulating the light rays passing through the planar surface when the optical member is moving. The modulated light is detected by a light sensor arrangement which is preferably aligned in parallel with the reference axis and the modulated light rays. The light sensor is configured to detect light signals in a desired way to provide an output signal indicative of the motion of the optical member. The output signal is preferably a digital output signal with one or more channels.

[0016] In a preferable embodiment of the present invention, the optical motion encoder is designed as an optical shaft encoder processing a rotational movement around the reference axis, wherein the reflecting surface is a parabolic concave surface of an axially symmetric paraboloid of revolution having the reference axis as its axis of symmetry.

[0017] In a further preferred embodiment, the optical member is extended at the apex of the reflecting surface by a translucent shaft extending along the reference axis. Such a shaft, which is aligned with the light source, serves in this way as visual output of the light source for visual feedback. If the motion encoder according to the invention is a shaft encoder, said translucent shaft acts as a light pipe and can also be used as the shaft of the shaft encoder for mounting the encoder to the rotating object the rotary movement of which should be detected.

[0018] Due to the structural design of the motion decoder of the invention, the reflector and the encoding component can be assembled in a simple way thereby realizing the one-part optical member of the invention. The optical member can even be constructed as a translucent body of optical glass or plastics in the shape of a half of a paraboloid having its parabolic surface coated with a reflective coating to form the reflecting surface and having the code pattern printed or etched on its planar base surface.

Brief Description Of The Drawings

[0019]

Fig. 1 is a schematic sectional view of an optical shaft encoder according to the present invention.

Fig. 2 is a schematic top view of the optical shaft encoder of Fig. 1.

Description Of The Preferred Embodiment

[0020] A preferred embodiment of an optical motion encoder embodying the principles of the present invention is shown in the drawings in the form of a shaft encoder. The shaft encoder comprises an optical member 1 which is mounted in an axially cantilevered manner to allow rotation about an axis 2. The optical member has the shape of a half of an axially symmetric paraboloid having a parabolic reflecting surface 4 formed by a reflective coating on the parabolic outer surface of the optical member 1, and having a planar surface 5 being perpendicular to the axis 2 as the base surface of the paraboloid. A code pattern of a desired shape and pattern in a circular row around axis 2 is applied to the planar surface 5 of optical member 1 by printing or etching or the like. Preferably, the code pattern comprises a plurality of alternating optically transmissive and non-transmissive areas.

[0021] A stationary point light source 3 is positioned in the focal point of the parabolic reflecting surface 4 on axis 2. A stationary light sensor 8 spaced from the planar surface 5 by a gap is located at the radial position of the code pattern and directed in parallel with the axis 2 to the reflecting surface 4. The point light source 5, which is a light emitting diode (LED), and the light sensor 8, constructed as a plurality of photodiodes, are integrated in a printed circuit board 9 further including an integrated detector circuit of a desired design. Alternatively, the light sensor 8 may comprise just a single photodiode.

[0022] During continuous or incremental rotation of the optical member 1 around axis 2, the light rays which are emitted by the point light source 7 are reflected by the parabolic reflecting surface 4 toward the planar surface 5 in a direction which is parallel to the axis 2 and are modulated by the code pattern 6 on the planar surface 5. The light rays are modulated by the alternating optically transmissive and non-transmissive areas of the code pattern. Modulated light rays passing through the code pattern are detected by light sensor 8 and are further processed by the detector circuit to receive a one- or more-channel output signal which is indicative of the rotary movement of the optical member 1.

[0023] At the apex of the parabolic reflecting surface 4 on the axis 2 of rotation, the optical member is extended by a light shaft 10 receiving that light output of the point light source that does not hit the parabolic reflecting surface 4 thereby acting as a light pipe for a visual output of the light source 5.

[0024] The optical member 1 of the encoder according to the present invention is preferably a single optical plastic part with the integrated reflector surface 4 realized by an reflective coating and the integrated code pattern 6 which is applied by printing or etching or the like to the planar surface 5. The light emitter 3 may be surrounded by a hemispherical light entrance surface 7 being spaced from the light source 3 by a small gap and having its center point on the focal point of the parabolic surface 4, which also includes the point light source 3, to minimize refraction as the light from the light source 3 enters the optical member 1. Further, a shield (not shown) may be designed in to block direct light trans-

a code pattern on the planar surface for modulating reflected light rays received by and passing through the planar surface of the optical member when the optical member is moving, and

a light sensor for detecting the modulated reflected light rays and providing a digital output signal which is indicative of the movement of the optical member.

10. An optical motion encoder as claimed in claim 9, wherein the movement of the optical member is a rotational movement around said reference axis and the parabolic reflecting surface is a paraboloid of revolution surface having said reference axis as its symmetry axis.

11. An optical motion encoder as claimed in claim 10, wherein the light source is surrounded by a spaced hemispherical light entrance surface of the optical member.

12. An optical motion encoder as claimed in claim 9, claim 10, or claim 11, wherein the optical member includes a light shaft extending through the reflecting surface along the reference axis.

13. An optical motion encoder as claimed in any one of claims 9 to 12, wherein the optical member is a light translucent body having a parabolic first outer surface which is coated to realize the parabolic reflecting surface and having a second outer surface opposite to said first surface and realizing said planar surface with said code pattern applied to said second outer surface.

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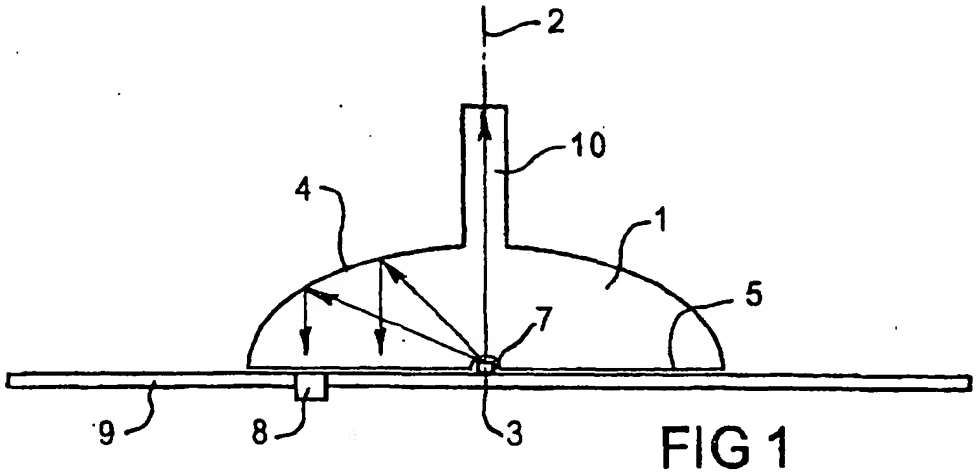

FIG 1

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 12 2137

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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